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Colour Photography by Frank Hurley *Blocks by Courtesy of John Sands Pty. Ltd.*

TELOPEA SPECIOSISSIMA

THE WARATAH OF NEW SOUTH WALES

The characteristic crimson, rounded inflorescence is made up of numerous individual flowers and contrasts strikingly with the leathery, dark green toothed foliage.

HOW TO GROW WARATAHS

By P. J. PARRY

Telopea speciosissima, commonly known as the N.S.W. Waratah, is the national flower of that State, is the best known, and is the most popular of the Telopeas. They may be readily germinated from seed, as described later in this journal, or small plants may be obtained nursery grown.

The plants are planted out into their permanent positions at least three feet apart. The position chosen should be well drained to a depth of eighteen inches with reasonable sunshine available. The type of soil into which the waratah is planted does not appear critical. They have been known to thrive in all soil conditions from a light bush sand to a heavy clay, a good loam being preferred. The important factor appears to be a good depth of soil well drained to the whole depth. At this stage watering twice a week should be sufficient. When they commence to grow and become established, watering can be restricted to windy or dry weather. Waratahs are capable of flowering in three or four years from the time of seed sowing. They respond well to occasional dressings of "blood and bone."

When plants come into bloom the flowers can be cut for indoor decorations or left on the plant until they die. If left on the plant the stems should be pruned back to about half the length of each stalk, and shoots will soon appear from above leaf nodes. It is a mistake not to prune, as plants will become scraggy and often fail to bloom during the following season. The setting of seeds will also interfere with future flowering. One waratah bloom is capable of producing as many as two hundred and fifty seeds. Plants grown under cultivation, given proper care and feeding, should bloom each year.

On an average, waratahs growing in the natural bushland flower in quantity once in every five years. This is quite understandable when one takes into consideration droughts, bushfires, floods and the struggle for survival with other natural shrubs and trees. It is true that the second year after a bushfire the waratahs will bloom in profusion. This is because of the new growth to carry the bloom, but pruning promotes this new growth when carried out in the proper manner. My cultivated area is never fired and produces over 5,000 blooms every year.

Be wary about growing the waratahs with rotted wood, as was recently published, as they are susceptive to armillaria and phytophera, root rots which thrive where rotted wood is in the ground.

Many years ago the late Mr. Harry Hazlewood and I both realised that there was a friendly fungus which associated itself with the waratah, but we were unable to decide whether this fungus was necessary for the plant's ultimate survival.

"HOW TO GROW WARATAHS"

Waratahs can be propagated from seeds or cuttings, but the usual and most reliable method is from seeds. They should be gathered from the parent plants when ripe, usually April or May, and sown in springtime.

For sowing seeds a bed or box should be prepared with loamy soil and leaf mould. The seeds should be lightly covered and watered daily to keep the surface soil moist. The seed bed is kept covered with glass until germination takes place. Then gradually harden off the plants by lifting cover each day.

THE TREATMENT OF SEED

By H. BOYD

The writer is the honorary propagator for the Native Plant Propagation and Research Society, has had to do with the germination of seed for more than 20 years, and is a foundation member of this society.

STORAGE OF SEED

The proper and careful storage of seed ensures greater viability and longer life of the seed. Seed may be stored in sealed paper packets, but if kept for a period, it is preferable that it be stored in screw-topped jars in a darkened place. It is important that insects and moisture are entirely eliminated from seed in storage. The reason for the elimination of moisture is that bacteria and fungi can only grow in the presence of high humidity. As a safeguard against insecta and fungi it is wise, where the seed is to be stored for a lengthy period, to include a little D.D.T. powder and 'Captain" with it. The former is an insecticide and the latter a fungicide. If seed is infected by insecta or small animals, it is also infected with cellulose digesting organisms. This is because most of these beasts depend upon cellulose digesting organisms living symbiotically in their gut to break down cellulose for their own metabolism, and so, if infected seed is sown in sterile or sanitised soil, the germ count would soon be very high. Perhaps a very strong culture will develop and all viable seed and small plants will be destroyed.

PREPARATION OF SOIL

The soil should be sterilised or rather, sanitised, this being a better term. The complete sterilisation of soil would be very difficult to achieve. What is achieved by the technique recommended is the great reduction in the number of pathogens in the soil and so the term sanitisation. The small plants can then grow to a good size before the wogs again build up to a significant proportion.

A method for the sanitisation of soil is as follows:—Place wetted soil on a sheet of iron under which a fire is lighted. Cover the soil with a bag. The soil temperature will not by any great amount exceed 212 deg. F. if well wetted. I might take a while for the mass to reach this temperature depending upon the mass of soil and the heat from the fire. The writer urges the use of a thermometer. The soil should be held at 212 deg. for about 15 minutes. Considerable harm can be done to the soil if this temperature is exceeded. It should then be cooled as soon as possible.

GERMINATION OF SEED

Method 1

Germination of seed of the Telopeas. In the propagation of waratah (*Telopea speciosissima*) from seed a simple technique is used. Very coarse bush sand, small stones and dried banksia leaves are mixed to form an open media and then placed in a seed box. The seed is then placed on top and covered to a depth of one quarter of an inch with finer sand. Paper is then laid flat on the surface until germination takes place. The best conditions are for the surface to be moist but not very wet, and the paper helps to achieve this condition. The whole must not be allowed to dry out, and for this reason the use of a seed box and not terracotta pots is recommended. Do not cover with glass. The whole experiment must take place out of doors in full sunlight. The paper may be removed after the seed germinates.

Plants grown in full light using this technique do not tend to damp off as readily as those grown under glass or in a glasshouse. After the second leaves form, give a light dressing of blood and bone. The plants may be transferred from the seed box to a pot or tube containing the same media as used for germination above, when about three to four inches high, being careful not to injure the roots. In the propagation of waratahs, full light and perfect drainage is essential.

The reason for mixing banksia leaves through the media is that the writer has seen the partly decayed leaves attached to the roots of the waratah by mycorrhiza or fungal threads, and is of the opinion that this plant lives symbiolitically with a fungus. For this reason do not remove any leaf material adhering to the roots of the seedlings when they are being potted from the seed box.

Method 2

Alternative method for the germination of waratah seed. Another method for the germination of waratah seed is to place a quantity in the bottom of an aluminium ice cream tray.

Mix the seed with vermiculite to the proportions of approximately four parts of vermiculite and one part of seed. Wet the mixture with a nutrient solution, say "Foli 8" or "Aquasol". Drainage holes in the ice cream tray are not necessary, the amount of nutrient solution being sufficient only to wet the mixture to form a pug or stiff dough-like mass. A nutrient solution is a solution of a liquid fertiliser and water mixed in the proportions recommended by the manufacture of the fertiliser. The covering of the tray with glass is not necessary although the use of glass may help to retain the moisture. The tray is kept in a sunny position, such as inside on a window sill, care being taken that the mixture is retained in its moist cohesive state. The seed must be constantly observed. When the radicle (the first root) begins to emerge and the cateledons begin to open, the seed can then be taken and placed in wooden or metal tubes containing three parts boiler ash that has been passed through a quarter inch sieve, and one part unsterilised bush sand that contains a fair amount of decaying leaves. The germinating seed is planted to a depth of three quarters of an inch in top of the tubes. Good growth and very little damping off is had if the plants and tubes are given adequate ventilation and light.

In common with the other plants of the family Proteaceae and in fact most native plants, adequate ventilation and light is essential, but the use of a glass house is not recommended. When they are first planted out in pots from the seed box they should be placed in a shady position with filtered sunlight for about ten days. They may then be moved to receive increasing exposure to sun until they get full sun. However, if in full sun the problem is to prevent them drying out. Nurserymen dealing with large quantities may find it necessary to keep them in a less sunny position with frequent watering, although the burying of the pots or tubes in boiler ash is an excellent method.

Method 3—See Vol. 1, No. 7 "Australian Plants"—June, 1961.

THE PROTEACEAE

By J. G. McKERN

All Australians who know anything of our bushland at all can recognise some of its prominent members — the Banksias, Waratah, Geebungs or Persoonias, Hakeas or Needle Bushes, and the so-called Spider Flowers—the Grevilleas. It may, at first sight, seem strange that these plants, outwardly of very different appearance, should belong to the same family. But close inspection of the flowering portion shows that in most cases the "flower" consists of a number of small flowers, basically not very different, but somewhat differently arranged.

For example, the inflorescence of the Banksia is actually a spike of some hundreds of tiny flowers in a cylindrical or ovoid or even globular arrangement. That of the Waratah is a "head" of a great number of flowers, put together in a conical arrangement surrounded by a large collar of coloured leaves or "bracts". In the Grevilleas, the small flowers are stalked and form a raceme, sometimes resembling roughly a toothbrush, or at times like the spokes of a wheel.

But each of these small flowers in all members of the plant family Proteaceae has the following common characteristics:—

(a) Absence of one portion of the perianth, usually the calyx.
(b) Four petals and 4 stamens, each stamen in front of a petal and often attached to it.
(c) Many have tough, leathery, crowded or divided leaves.

Most have long protruding pistils, and the stigmas are held between the stamens until the pistils growing more rapidly than the corollas, form loops which burst through the sides of the corollas. In some species, the curved styles, although eventually freed, remain looped and give the characteristic elegant appearance of the Grevilleas and some of the Banksias. In other species the styles straighten, and this difference in behaviour assists in recognition.

Plants found naturally in light poor soils often perform better in heavier or richer soils, while others such as the Silky Oak—*Grevillea robusta*—found naturally in deep moist soils, do reasonably well almost anywhere. Loss of moisture by transpiration through the leaves is minimised by the nature and shape of foliage, and by hairy covering which protects leaves, flowers and other parts of the plant.

Some have one crop of flowers only in the year, while others, particularly some Grevilleas and Lambertia, are in flower during most months. Flower colour varies from white to cream, yellow, pink, red, blue and green.

The fruits may be of various types:—

(a) Soft and fleshy with a hard stone containing 1 or 2 seeds as in Persoonia. Some are nuts as with Macadamia.
(b) Small hairy nuts, which do not open of themselves and contain one or two seeds—In Isopogon, Petrophila, and Conospermum.
(c) Hard and woody—which split to release two winged seeds, as in Lambertia, Xylomelum, Hakea, Banksia.
(d) Leathery pod-like follicles—which split on one side only—true pods open on both sides—and release a number of winged seeds—as in Telopea, Lomatia and Stenocarpus.
(e) Leathery follicles—which split on one side and release two wingless seed—as in Grevillea.

How I Grow Waratahs

By H. BRACKPOOL

Plant the seeds as soon as pods ripen (about April) and begin opening on the plant. This minimises the danger of damping off. Use a five inch terracotta pot, not smaller. The larger the pot the better. (I find that tins when rusting have a toxic effect on many plants). Use grey bush sand or the like as a potting medium with about one third drainage material. Water daily or do not allow to dry out. Keep in a shady filtered sunlit position, one or two seeds to a pot. The seeds will keep on coming up at various intervals until November or December. You won't rear all your seedlings but you could rear most of them. In two or three months, if you wish, some can be transplanted with a bricklayer's trowel to other pots with the minimum of root disturbance. Actually one seed to each pot would be better, and if this has not come up by December another can be put in near the first one in the centre. If the seeds are planted late in the season or receive any root disturbance, the greater is the danger of losing your seedlings from damping off.

The plants should not be put out into the open ground before the May, preferably two years, after the seeds were planted. This gives all winter for the roots to get used to their new positions and the plants are large enough and able to stand the summer sun. If in full sun, they should be shaded for the first summer or two. Plants put out after one year or put out in September-October will usually die. Another equally important point is not to water the young plants is hot weather, but mulch with dead foliage or the like. If the weather is too hot and the plant is watered, the excess moisture goes to the leaves and the plant quickly wilts and dies, killed by the heat and mistaken kindness. It seems better to let nature look after them once they are planted out by watering at all, and, of course, a well-drained position in full sun or facing the north is preferable. Where I do the foregoing the plants usually make good headway, and very rarely die. When the plant reaches eight to twelve feet, you can prune or shape it as you desire but do not cut out the new canes that come up from the base.

Propagation methods are so many and varied that it can be a mistake so often to say "this method is wrong" or "that is wrong". You can only state what you yourself have found to be successful. My method is as follows:

When preparing a pot for seeds I usually place a curved piece of broken terracotta pot over the drainage hole, fill to about one third with small pieces of coke or stones, then put some dead *Banksia ericifolia* needles or crushed dead gum leaves or others on top of these, and then almost fill the pot with bush sand or the like. Place seeds on top and for waratahs, cover with about one quarter of an inch of bright sand and finish with the level just low enough to take the watering.

Before planting out when ready, dig a hole about the size of the pot, fill with water, water pot thoroughly, then turn upside down over fingers and push soil and plant into hand with a pencil or stick pushed through the drainage hole to contact the piece of broken pot at the bottom and bring the watered plant away cleanly. Then, take away the broken piece of terra cotta from the base of the potball and place plant in the now drained-away hole. It is better not to firm the soil around the plant very much; just work the soil around it and water to firm.

EDITOR'S NOTE: There is a study section on waratahs which interested readers may join and share in the activity of growing these spectacular plants with the benefit of expert advice, free seed, etc. Without any prior experience you can contribute to the development of better flowers and plants and add colour to your garden by writing to Mr. H. G. Bleakely, Ridge Rd., Kallista, Victoria.

THE GENUS TELOPEA

By J. L. WILLIS, M.Sc.

Director, Museum of Applied Arts and Sciences, Sydney

The family *Proteaceae* is a very ancient, widespread family occurring in Australia, New Zealand, South Africa, South America, and Eastern Asia. It contains about 60 genera of which 37 are indigenous to Australia.

Included in the plant family *Proteaceae* is *Telopea*, a small, endemic genus which contains four species only, all of which are confined to the south-eastern regions of the continent and the island of Tasmania. The name *Telopea* is derived from the Greek "telopos", meaning "seen from afar", and refers to the conspicuous nature of the crimson heads of flowers which stand out from the dark green foliage in a striking fashion. The aborigines called these beautiful shrubs "Waratah", and this is now the generally accepted vernacular name.

Of the four species, *Telopea speciosissima* R.Br. (meaning "very handsome") is perhaps the most familiar. This species occurs in New South Wales from Gosford, Putty and the Blue Mountains, south to Conjola, and is found only on sandstone. There is also an isolated occurrence in the ranges north-east of Glen Innes at Glen-Elgin. The comparatively rare *T. mongaensis* Cheel (referring to the district of origin, Monga) is also a New South Wales species occurring east of Braidwood at Monga, Currockbilly, Clyde Mountain and Sugarloaf Mountain. The third New South Wales species *T. oreades* F. Muell. (meaning "belonging to the mountains") occurs in the Bombala district and far South Coast of New South Wales, extending into East Gippsland in Victoria. The fourth species *T. truncata* R.Br. (meaning "truncate" —referring to the flattened flower heads) is endemic to Tasmania, where it is widespread in the wet, mountainous regions.

INFLORESCENCE

The flowers of all *Telopea* species are arranged in dense, terminal, racemose clusters. As in all racemes, the flowers are borne on separate stalks, but they arise in pairs so close together on the rachis that they touch one another, and give the inflorescence the appearance of a head. The size and shape of the inflorescence varies with the species. The oldest flowers are at the base of the flower head, and the youngest ones are at the apex, and as a consequence the upper flowers are often still in bud when the lowest ones are fully opened. In all species the inflorescence is surrounded at the base by an involucre of large, red bracts which vary in size according to the species.

FLORAL STRUCTURE

The individual flowers of Waratahs are small and are built up in parts of four. There is no separate calyx and corolla, instead, the flower parts consist of four perianth segments which, in the bud, appear to be fused together. This fusion, however, is not a true one, as the four segments can be separated by gently twisting the bud. This apparent union of the perianth segments is related to the pollination mechanism. Each perianth segment is somewhat strap-like in appearance with a hollowed out lobe at the apex,

the four lobes forming an apical swelling which is curved towards one side (see Figure 1). The flowers are consequently bilaterally symmetrical. Inside the swelling are four sessile anthers, that is, anthers without filaments, one to each perianth segment. Each of these sessile anthers, in the bud, is in close contact with the rather conical-shaped stigma, which is placed laterally towards the end of the style (see Figure 2). As the flower matures, the style grows faster than the perianth segments, and in order to make room for its increase in length, forces its way between the perianth segments, splitting them, and emerging in the shape of a hook, so typical of the Waratah flower and its allies (see Figure 3).

The ovary, which is produced on the end of an elongated stalk known as the gynophore, is superior, and consists of one carpel containing a large number of ovules, whilst the nectary, which is located at the extreme base of the gynophore, is in the shape of an incomplete ring (see Figure 2). The fruit formed from the ovary after fertilisation is a follicle of leathery texture up to five inches long, containing many seeds which are quite flat and winged.

DESCRIPTION OF SPECIES

The following is a brief description of the four species, which can readily be separated by the leaf and inflorescence characters:—

1. *T. speciosissima* ("Waratah") (Pronounced spec--cio-siss-ima)

Stout, erect shrubs up to about 8ft. iin height, with alternate leaves 5-10 inches in length, sharply toothed in the upper part, from oblanceolate to obovate or almost cuneate, with prominent venation. Flowers in dense, ovoid or globular heads, 3-4 inches in diameter; iinvolucral bracts crimson, ovate-lanceolate, the inner ones being 2-3 inches long. Fruit, a leathery follicle 3-4 inches in length.

2. *T. oreades* ("Gippsland Waratah") (Pronounced or-e-a-des)

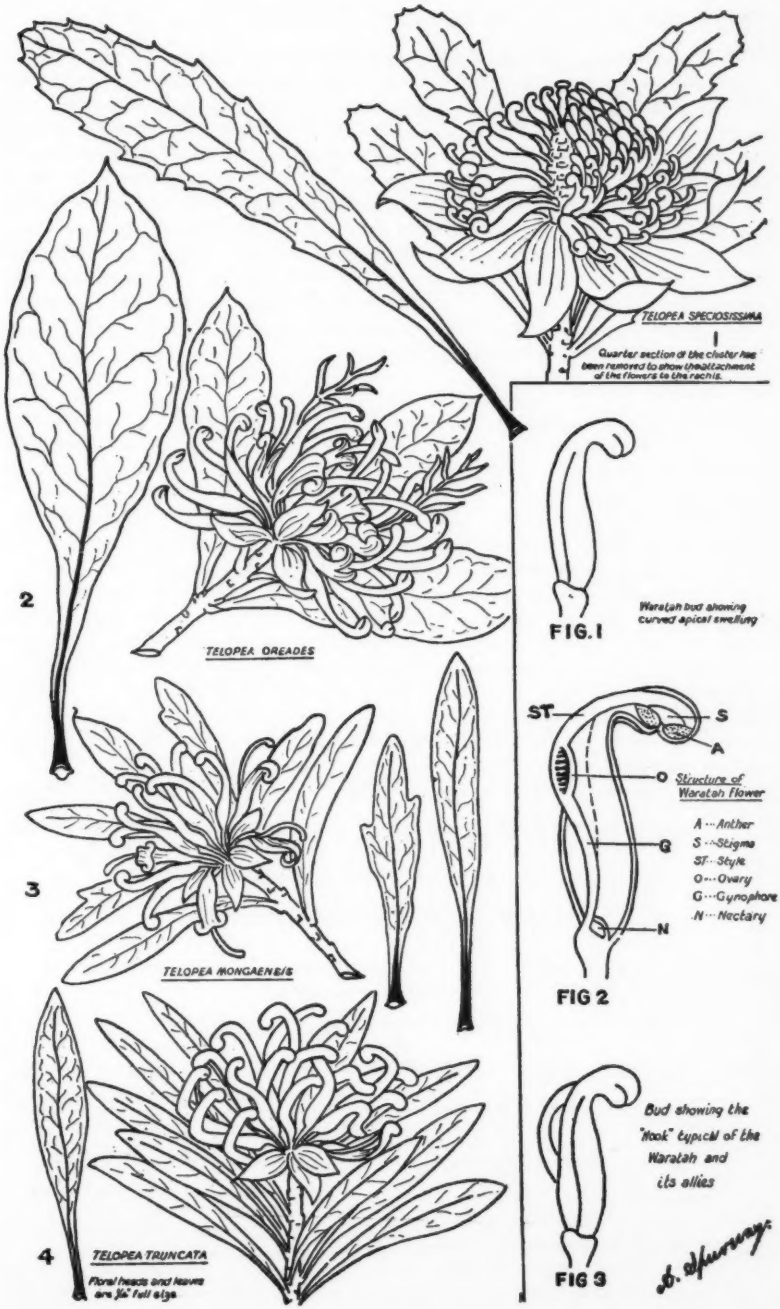
Gully and mountain shrubs, sometimes attaining tree height (up to 30-40ft.) with a stem diameter of 1-2ft. Leaves alternate, 4-8 inches in length, usually entire from obovate to lanceolate, often glaucous on the under-surface, with the mid-rib alone conspicuous. Flowers in ovoid or globular heads about 3 inches in diameter, with surrounding involucral bracts under 1 inch in length. Fruit, a leathery follicle 3-5 inches in length.

3. *T. mongaensis* ("monga Waratah") (Pronounced monga-en-sis)

Slender, branched shrubs from 4-8ft. in height, with alternate leaves 3-4 inches in length, narrowly lanceolate to oblanceolate, entire or with 2-3 sinuate lobes at the apex, slightly paler on the under-surface, inconspicuously veined. Flowers in short, broad, rather flat heads about 3 inches in diameter; involucral bracts crimson, mucronate, sparsely fringed on the margins with rust-coloured hairs, about ½ inch to 1½ inches long. Follicles 2-3 inches in length. There are no grounds for the assumption made by some writers that this species is a hybrid between *T. speciosissima* and *T. oreades*.

4. *T. truncata* ("Tasmanian Waratah") (Pronounced trun-ca-ta)

Erect or spreading shrubs from 5-10ft. in height, with alternate leaves 2-4 inches in length, from oblanceolate to obovate, entire, the margins often recurved, venation inconspicuous. Flowers in short, dense, flat heads about 2 inches in diameter; involucral bracts ovate, covered with appressed hairs,


TELOPEA SPECIOSISSIMA
Quarter section of the cluster has been removed to show the attachment of the flowers to the rachis.
2
TELOPEA OREADES
FIG. 1
Waratah bud showing curved apical swelling
ST
S
A
O
Structure of Waratah Flower
A ... Anther
S ... Stigma
ST ... Style
O ... Ovary
G ... Gynophore
N ... Nectary
G
N
FIG 2
3
TELOPEA MONGAENSIS
4
TELOPEA TRUNCATA
Floral heads and leaves are 1/6 full size
Bud showing the "Hook" typical of the Waratah and its allies
FIG 3

the inner (and longer) bracts being ¾ inch long. Follicles 2-3 inches in length.

POLLINATION

Waratahs are pollinated by insects and birds, and as the flowers are markedly protandrous they are almost invariably cross-pollinated. Whilst the flower is still in the bud stage, the anthers, which for a long period are held in close contact with the stigma, dehisce, and shed their pollen directly on to the stigma. The continued growth of the style finally splits open the perianth segments, and frees the stigma with its load of pollen. Insects or birds, searching for nectar, brush against the stigma and eventually remove all the pollen grains. In the meantime the flower is becoming over-mature and the perianth segments are losing their attractiveness, and it is during this period that the stigma, now free of its own pollen, becomes receptive. Insects or birds in search of nectar now rub their pollen loads, acquired from other flowers, against the stigma, the pollen sticks to the stigma and germinates, thus ensuring fertilisation.

ECONOMIC VALUE

Although the Waratah has been used widely in applied art, particularly as a motif in woodcarving, ceramic and glassware design, etc., it has little commercial use apart from its proven horticultural value. *T. speciosissima* is the most widely grown of the four species, although *T. truncata*, *T. oreades*, and a striking yellow form of *T. truncata* have all been grown in the eastern States for ornamental purposes. Although attempts have been made to cultivate *T. mongaensis* in the Sydney district, no success has attended these efforts.

The timber of *T. oreades* is regarded as being one of the most beautiful Australian ornamental timbers. It is a close-grained, medium weight, light-coloured timber which planes and polishes well, and in figure, character, and texture it is very similar to the American Sycamore. The quantities of timber obtainable from this source, however, are not great, which is perhaps fortunate, as past experience has shown that the exploitation of plants of economic value but restricted distribution, has led, in some cases, to the virtual extinction of the species.

THE INFLORESCENCE

By R. C. Carolin, Lecturer in Botany, University of Sydney

"The inflorescence" means, quite simply, the mode of flowerinng. The term is not applicable to any structural unit but it and its subsidiary terms outlined below merely indicate the manner in which flowerinng takes place. Thus the inflorescence does not include, in the structural sense, the flowers, peduncles, pedicles, bracts, etc. Its subsidiary terms describe the relationships of flowers to each other and the other parts mentioned, being used generally to describe the flowering of plants where the individual flowers are grouped in a cluster. It should also be borne in mind that the mode of flowering of any particular species may not be constant throughout its range, indeed the same plant may exhibit different inflorescence in different years or even during different seasons of the same year.

The terms outlined below are not entirely exhaustive. They represent those most commonly in use at the present time and are ample to describe all inflorescences. The diagrams attempt to portray in two dimensions what actually occurs in three. This can be particularly misleading in the case of the monochasia and it might be profitable to construct models of these using matchsticks and plasticine.

CYMOSE INFLORESCENCES

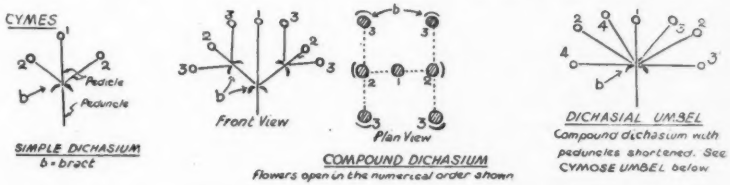
Cymes—in which flowers are arranged in a descending series of youth, the oldest flower appearing to be at the top of the inflorescence branch system, or in the centre of it. Commonly called DETERMINATE as each flower clearly terminates the growth of the flowering branch system and further growth is by lateral branch(es).

DICHASIUM (Pronounced DI-K(cha)—SIUM)

A cyme inflorescence in which two lateral branches occur beneath the terminal flower.

Simple dichasia (plural for dichasium) are found in Nothofagus the Southern Beech.

Compound dichasia are arranged as shown below. A collection of compound dichasia may form a floral head and if this head assumes a pyramidal shape, it is known as a THYRSE, e.g., *Sprengelia incarnata*.



SIMPLE DICHASIUM

COMPOUND DICHASIUM
Flowers open in the numerical order shown

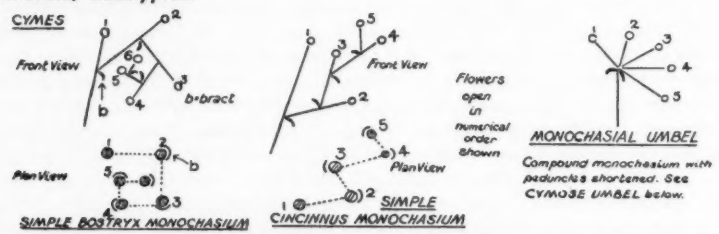
DICHASIAL UMBEL
Compound dichasium with peduncles shortened. See CYMOSE UMBEL below

MONOCHASIUM—(Pronounced Mono-cha-sium)—A cyme with one lateral branch occurring beneath the terminal flower.

(a) BOSTRYX: The lateral branch always occurs on the same side (in the diagram the right-hand side) and, viewed from above, the flowering system presents a spiral appearance, e.g., *Patersonia*.

(b) CINCINNUS: The lateral branch occurs on alternate sides and, viewed from above, the flowering system presents a zig-zag appearance, e.g., partial inflorescence of Xanthorrhoea (Black boy or grass tree).

CYMOSE UMBEL—A compound dichasium or monochasium in which the peduncles have been shortened and the pedicels arise from the same point. The oldest flowers are in the centre or on one side, e.g., *Pelargonium, Burchardia, Eucalyptus.*



The familiar terms SCORPOID and HELICOID cymes are ommitted as they have been applied in a number of different ways. In general the former refers to the CINCINNUS and the latter to the BOSTRYX.

RACEMOSE INFLORESCENCE

In which the flowers are arranged in an ascending series of youth, i.e., the oldest flower at the base of a common axis. Commonly called INDETERMINATE, as the common axis is apparently continuous in its growth. This form of inflorescence can be derived from a series of simple dichasia arranged along a leafy axis by the abortion of the lateral flowers as in the diagram.

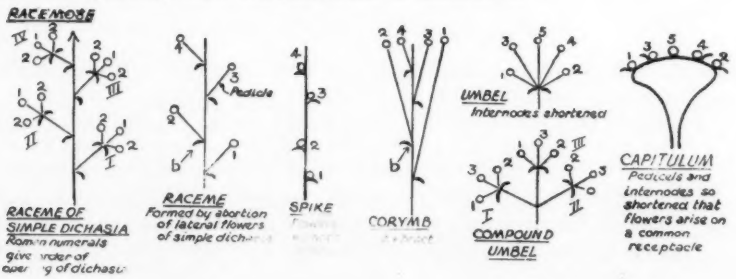
RACEME—in which the flowers are stalked (pedicellate) e.g., *Grevillea banksia, Persoonia, Goodenia Sp.* A PANICIE is simply a collection of racemes arranged in a raceme, i.e., compound roceme.

SPIKE—in which the flowers are not stalked (sessile), e.g., *Callistemon.*

CORYMB—in which the pedicels alongate in such a way that all the flowers are borne at the same level.

UMBEL—in which the pedicels are attached at the summit of the axis, the oldest flowers on the outside, e.g., *Hydrocotyle,* derived from the raceme by shortening of all the internodes. Compound umbel is a collection of umbels arranged in an umbel, e.g., *Trachymene, Didyscus.* Occasionally the umbel may take on the appearance of a capitulum, e.g. *Actinotus* (Flannel Flower), which is actually a simple umbel.

CAPITULUM—in which both the pedicels and internodes of the racemose types have become so shortened that the flowers arise on a common receptacle. Clearly the capitulum derived from the raceme will have the oldest flowers on the outside, e.g., *Brachycome, Olearia,* indeed, the whole family Compositae. The capitulum derived from the compound umbel will have an apparently more irregular mode of maturation.



Nutrition of Waratahs

By N. J. HANNON

The plant species which are native to Australia, particularly the indigenous element of the Australian flora, are world-renowned for their great variety, and remarkable diversity and peculiarity of morphological form. Many of these have evergreen long-lived leaves are of a tough, leathery nature—in botanical language, they are described as "sclerophyllous". This condition is caused by the high content of woody, or lignified tissue.

The outstanding feature of the Australian soils, on which these endemic species grow, is their low content of the minerals required for plant nutrition. The chief deficiences are of phosphorus and usually of nitrogen, as well as of other elements. Such soils are widespread throughout Australia, occurring in every State. Botanists are giving serious consideration to the possibility that the low levels of soil mineral nutrients is one of the factors that has contributed to the development of the harsh-leaved nature of the Australian species in the geological past. These endemic species certainly are very well adapted to the mineral deficient soils and their nutrition is obviously very different from that of the typical soft-leaved or "mesomorphic" species. It is significant that even when competition from the iindigenous vegetation is removed, introduced species, including those aliens regarded as weeds, often fail to become established in these virgin soils, unless the nutrient status of the soil is increased.

Analysis of leaf tissue is relevant to this matter since such data can, under certain circumstances, reflect the level of available nutrients present in the soil in which the plant is growing. It is of interest to note the data concerning the phosphorus and nitrogen content of *Telopea* leaves presented on page 15 of "Australian Plants", 1/1/59. As the data stands, it appears that high internal levels of phosphorus are not conducive to vigorous growth in Telopea. The values for phosphorus in samples 1 and 2 certainly are very high by comparison with phosphorus levels frequently found in leaf tissue of sclerophyllous species. In analysis of this kind, it is important to ensure that the samples all consist of leaves of similar age and size. As a leaf grows and expands in size, its nutrient concentration will usually decrease from an initial high level. The proportion of woody to soft tissue in each sample is also significant. The vigour of the plant will probably be determined by the relative concentrations of nutrients occurring in its active, living soft tissue rather than in the dead woody tissue. It should also be noted that concetration values (i.e., % values) may often be deceptive. Expression of data on an absolute basis, i.e., in terms of milligrams of nutrient per leaf, is often a useful supplement to concentration data.

When growing *Acacia suaveolens* (sm.) Willd. under controlled nutrient conditions, the author has found that this species also will not tolerate the application of high phosphate levels in nutrient medium. It would appear that the ratio of the content of phosphorus to that of other nutrients is of particular significance. These observations indicate that, by liberal application of fertiliser to native species under cultivation, it is relatively easy to "kill them with kindness". Doubtless this has been the experience of many readers.

The nutrition of the native Australian plants is very incompletely known and the fact that they not only survive, but also develop vigorously in such nutrient deficient soils demands explanation. It is to be hoped that investigations similar to those of the Telopea Study Group will be continued, as much valuable information will certainly emerge from these studies.

What's New from W.A.

By G. W. ALTHOFER

Though the eastern states have their share of floral munificence it is to the west that we confidently turn for new and exciting plants. Due to the indefatigable work of that wizard of plant lore, A. J. Gray, our gardens are constantly being enriched by the addition of little known or really rare plants. Because of the tremendous development in the west, many plants are becoming perilously close to extinction, so that it behoves all lovers of plants to hold them in gardens or sanctuaries. The chance may not come again.

BANKSIA BROWNII is just such a plant. It is one of those rare comers from the wilds, destined for immediate success and a lasting place in the gardens of the world. With an ultimate height of 6-8 feet, this beautiful plant is a tidy, compact bush, handling perfectly in nursery and garden. Long soft arching fern-like leaves and stiff brush-like flowers of dark red and gold makes *Banksia brownii* a delight in every way. Give it a well-drained position in any soil. Flowers in April—9 inch brushes. The rarest of all Banksias.

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How Do Waratahs Grow?

By H. G. BLEAKLEY, Leader of the Telopea Study Group

Generally speaking, *Telopea speciosissima* growing in Victoria is limited. It grows well in the Dandenong Ranges and possibly in other similar localities, but most attempts to grow it in Melbourne and suburbs have resulted in failure. A study group has been formed under my leadership to determine why this should be so. Those wishing to assist (no special experience is necessary) should write to me Ridge Rd., Kallista, Victoria.

There are two schools of thought.

Mycorrhizal Fungus Association with the Roots

Many people who have studied this problem think that a mycorrhizal fungus association with the roots is necessary for waratahs to thrive. The mycorrhizal theory, which is supported by work done on Proteas, is strongly supported by experienced growers. One leading nurseryman goes as far as to destroy all seedlings, which, in repotting from three inch pots to larger ones, fail to show a fungus growth about the size of a shilling on the roots where they have been in contact with the pot. He maintains that he has proved that, without his fungus (which may be mycorrhizal but so far has not been identified), the plant is doomed to failure. Further evidence is needed. The mycorrhizal fungus is common in poor and sandy country but little is known apparently about its distribution in soils such as those of the Dandenongs, or of its chemical contribution to the plant with which it is associated.

Research in the School of Botany at the University of Melbourne, has been working for some time on the nutritional requirements of the *Proteaceae*, of which the *Telopeas* are, of course, members. At this stage there is no positive evidence that a mycorrhizal fungus association with the roots of the *Proteaceae* plants is necessary for their growth. However, research by a very competent team in Sydney by simply growing Waratahs in your garden to our instructions.

Soil Chemical Theory

Another theory is that soils with high nitrogen and low phosphate are those which grow good waratahs. Some interesting evidence supports this theory.

An analysis of leaves of waratahs grown at Beaumaris and Sandringham was undertaken by J. Addison, 56 Station Street, Burwood, Victoria, with the following results:—

SAMPLE	GROWTH OF SHRUB	NITROGEN	PHOSPHORUS	N/P
No. 1	Fair	0.80%	0.31%	2.6
No. 2	Better	0.89%	0.12%	7.4
No. 3	Good	0.62%	0.03%	21
No. 4	Excellent	0.77%	0.03%	26

In addition the manganese content of No. 4 was 1,310 parts per million. There were insufficient samples to test the others. All results of leaf analysis are "dry basis." The interesting facts are the very low phosphorous content of the healthy leaves, the rising N/P ratio with increasingly good growth and the exceptionally high manganese content of sample 4.

The article "Nutrition of Waratahs" on page 13 supports this theory. The use of fertiliser in the form of "blood and bone" has been proved as beneficial to Waratahs however. Evidence so far supports Mr. Parry's remarks in this issue that the type of soil does not matter so much, providing that the drainage is good. However, soil analysis on samples taken from places where waratahs grow will suggest that the following characteristics give the best results.

TASMANIAN WARATAH

TELOPEA TRUNCATA

The inflorescence is flat and the individual flowers are not as compactly arranged as in the mainland species. The leaves are inconspicuously veined and the margins are always entire.

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